PATENT ABSTRACTS OF JAPAN

(11)Publication number : 11-345698
(43)Date of publication of application : 14.12.1999

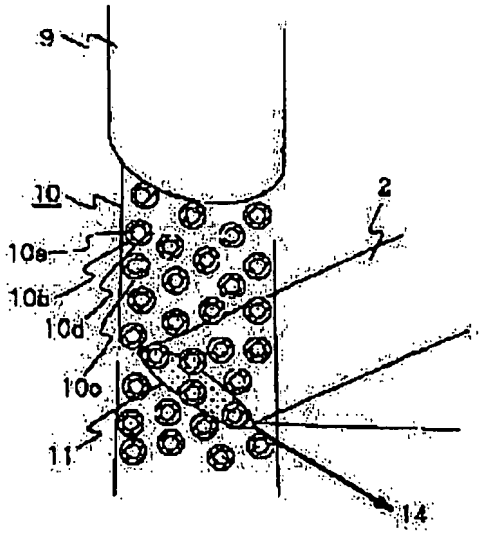
(51)Int.Cl. H05G 2/00
G21K 5/02
H01L 21/027

(21)Application number : 10-155582
(22)Date of filing : 04.06.1998

(71)Applicant : HITACHI LTD
(72)Inventor : KONAKAWA NOBUYOSHI
MATSUI TETSUYA
NISHI MASATSUGU

(54) LASER PLASMA X-RAY SOURCE, SEMICONDUCTOR EXPOSING DEVICE USING IT AND SEMICONDUCTOR EXPOSING METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To decrease production of debris and to enhance X-ray conversion efficiency.
SOLUTION: A corpuscle mixed gas target 10 is composed of corpuscles 10d formed by coating metal 10b such as gold on an organic material 10a such as polystyrene and gas 10c having high X-ray permeability, and an X-ray 14 is obtained by irradiating a laser beam 2 to the corpuscle mixed gas target 10. The diameter of the corpuscle 10d coated with the metal 10b is preferably smaller than that of the laser beam 2 irradiated to the target 10.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] It is the laser plasma X line source characterized by to have the target fuel injection equipment which a laser beam is irradiated within a vacuum housing at a target, the plasma is generated, and said target mixes the particle and the gas which coated the matter with specific gravity smaller than said metal with the metal in the laser plasma X line source which generates an X-ray from the plasma, and injects said target, and laser-radiation equipment which irradiate said target which had said laser beam injected.
[Claim 2] Said matter is the laser plasma X line source of claim 1 characterized by being an organic substance and being a polymer particle.
[Claim 3] Said polymer particle is the laser plasma X line source of claim 2 characterized by being the polymer particle of a polystyrene system.
[Claim 4] The path of the particle which coated said metal is the laser plasma X line source of claim 1 characterized by being smaller than the path of the laser beam irradiated by said target.
[Claim 5] The ingredient of said metal is the laser plasma X line source of any 1 term from claim 1 characterized by being gold, tin, or a tungsten to claim 4.
[Claim 6] Said gas is the laser plasma X line source of claim 5 characterized by being nitrogen, air, helium, an argon, oxygen, or neon.
[Claim 7] The laser plasma X line source of any 1 term from claim 1 which is equipped with the target recovery system which has recovery opening which counters and carries out opening to the injection tip of said target fuel injection equipment, and collects said targets, and is characterized by being what irradiates said laser beam at said target between said injection tips and said recovery openings to claim 6.
[Claim 8] A semi-conductor aligner equipped with the condensing mirror which leads to a mask the X-ray generated in any 1 term from claim 1 to claim 7 in the laser plasma X line source of a publication, and said laser plasma X line source, and the X-ray cutback exposure mirror which reduces the X-ray which reflected with said mask, and is projected on a semi-conductor wafer.
[Claim 9] In the semiconductor device exposure approach which irradiates a laser beam at a target, is made to generate the plasma, leads the X-ray which was made to generate an X-ray and was generated from the plasma to a semi-conductor wafer, and exposes a semiconductor device pattern to said semi-conductor wafer The step which mixes the particle and gas which coated the matter with specific gravity smaller than said metal with the metal, and were made, and is used as a target, The step which injects said target in a vacuum housing, and the step which a laser beam is irradiated [step] at the target injected in said vacuum housing, and makes the plasma generate, The semiconductor device exposure approach characterized by leading the X-ray which was made to generate an X-ray and was generated from the plasma to a semi-conductor wafer, and exposing a semiconductor device pattern to said semi-conductor wafer.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention irradiates a laser beam at a target, generates the plasma, and relates to the laser plasma X line source which generates an X-ray from the plasma.
[0002]
[Description of the Prior Art] JP,6-281799,A indicates irradiating a laser beam at the solid-state target of the shape of a tape rolled round, and generating an X-ray.
[0003] JP,61-153935,A indicates irradiating a laser beam at the dropped liquid metal, and generating an X-ray.
[0004] JP,2-100297,A indicates irradiating a laser beam at the target of the shape of a buret smaller than the diameter of a spot of a laser beam, and generating an X-ray.
[0005] Japanese Patent Application No. 57-41167 A number official report indicates irradiating a laser beam at the particle of the solidified rare gas or water, and generating an X-ray.
[0006] "Office automation SUE trend Inn OPUTIKUSU- and - photonics, the 4th volume, the EKUSUTO ream ultra violet lithography (OSA, Trends inOptics and Photonics, vol.4, EXTREME ULTRAVIOLET LITHOGRAPHY) (1996), and 66 pages" of things for which application-of-pressure gas is injected in a vacuum housing, a laser beam is irradiated at the injected gas, and an X-ray is generated are indicated.
[0007]
[Problem(s) to be Solved by the Invention] If a laser beam is irradiated by the target, dielectric breakdown (optical breakdown) of the atom and molecule in a target will be carried out optically, they will be ionized, and the laser plasma will generate them. An X-ray occurs from the generated laser plasma. With the classes and conditions of an element of a target, laser beam reinforcement required for optical breakdown changes. Laser beam reinforcement in case optical breakdown takes place is called breakdown threshold.
[0008] A breakdown threshold is high in order of 1:gas (gas), 2:liquid, and 3:solid-state. In other words, the target of a solid-state and a liquid can generate an X-ray by laser beam reinforcement lower than a gas. Therefore, when using the target of a liquid and a solid-state, X-ray conversion efficiency (expressed with the energy of the generated X-ray to the energy of the irradiated laser.) is higher than the case where a gaseous target is used.
[0009] However, in the target of solid-states, such as the shape of massive [larger] than the diameter of laser, or a tape, and a liquid, propagation and a target fuse [the heat generated by the exposure of a laser beam] on the outskirts. And the target fused by the expansion pressure force accompanying generating of the laser plasma disperses, and it becomes several 10-micrometer debris. Debris adheres to the optical element in a vacuum housing etc., and does breakage.
[0010] Although debris will also decrease and X-ray conversion efficiency will not have a solid-state and a liquid, and a change since there is no particle in a perimeter if the target of a solid-state and a liquid is made into the shape of a particle smaller than the diameter of laser, it is difficult to set and supply a particle-like target to the exposure of a laser beam, and it also difficult to be stabilized and to generate an X-ray.
[0011] Although the target of the particle which froze the stable gas chemically [rare gas etc.] does not generate debris since it becomes a stable gas chemically [rare gas etc.] even if it fuses, it is difficult to supply and it also difficult to be stabilized and to generate an X-ray. Moreover, X-ray conversion efficiency is lower than a metal target.
[0012] On the other hand, since heat conduction to a perimeter is small and melting does not happen in a gaseous target

compared with the target of a solid-state and a liquid, there is little debris, and although it can be stabilized since it can supply continuously, and an X-ray can be generated, X-ray conversion efficiency is lower than a solid-state and a liquid.

[0013] The object of this invention has little generating of debris, and it is to provide the semi-conductor aligner list using a laser plasma X line source and it with high X-ray conversion efficiency with the semi-conductor exposure approach.

[0014]

[Means for Solving the Problem] The description of this invention of attaining the above-mentioned object is to irradiate a laser beam at the target with which the particle and gas which coated the matter with specific gravity smaller than the metal with the metal were mixed, it considered as the target, the target fuel injection equipment injected the target, and laser radiation equipment was injected. According to this description, heat conduction of the target which mixed the particle and the gas is small, and since melting of a particle does not happen, generating of debris can be lessened. Moreover, since the target which mixed the particle and the gas is injected, and serves as a fluid and a target is always supplied to the irradiated laser, stability can be made to generate an X-ray. Moreover, although the volume through which the laser beam of the target which mixed the particle and the gas pierces is the same as the case of a gaseous target Since a breakdown threshold is the same as that of a solid target and only a gas is lower than a target Since a plasma-ized possible field is larger than a gaseous target and many particles and gas molecules are contained to a plasma-ized possible field, the number of the particles which carry out optical breakdown Since only a particle increases more than the case of a target and a gaseous target, the brightness of the X-ray to generate can also make only a particle higher than a target and a gaseous target. Therefore, X-ray conversion efficiency can also be made high. Moreover, since the frequency where many particles exist in a plasma-ized possible field, and optical breakdown does not take place since the specific gravity of a particle-like target is made smaller than what constitutes a particle only from a metal, the consistency of a particle is generated in raising and high density can be made to generate a particle is 0, if a laser beam is irradiated, the laser plasma will surely be generated, and it can make stability generate an X-ray, without making a laser beam useless. Moreover, when the front face of a particle is a metal, X-ray conversion efficiency can be made still higher than a nonmetallic element.

[0015] Other descriptions of this invention are using a polymer particle among the organic substances which are easy to process it rather than mineral matter into the matter which coats a metal like claim 2. Since it is light compared with using a monomer particle, is strong and it lasts long by this, a uniform particle can be fabricated and stability and high density can be made to generate a particle. Therefore, stability can be made to generate an X-ray.

[0016] Moreover, the thing characterized by the thing [using the thing of a polystyrene system as a polymer particle] according to claim 3 like Even if the process in which heat can be applied is before being able to constitute the highly efficient particle for targets with the metal which is excellent in fabricating-operation nature compared with other polymer particles, and specific gravity is light and coefficient of thermal expansion coats since it is near, and receiving the exposure of laser The coated metal does not exfoliate, but the normal particle for targets is supplied to the exposure field (plasma-ized possible field) of laser, and stability can be made to generate an X-ray.

[0017] The brightness of the X-ray which generates what has the description in other descriptions of this invention being smaller than the path of the laser beam by which the path of the particle which constitutes the target is irradiated by the target like claim 4 since many particles exist by the plasma-ized possible field can be made higher.

[0018] Other descriptions of this invention are characterized by the metallic material of coating being gold, tin, or a tungsten like claim 5, and its generating reinforcement of 8-14nm soft X ray can be higher than copper and nickel, and they can generate an X-ray efficiently.

[0019] It is what is characterized by the gas from which other descriptions of this invention constitute a target like claim 6 being nitrogen, air, helium, an argon, oxygen, or neon. Since the high permeability to which the permeability of 8-14nm soft X ray exceeds 80% in all the bands of the wavelength is shown There is little attenuation with the gas of the generated 8-14nm soft X ray, and it is suitable to use it, wavelength's being able to take out the soft X ray of the condition that brightness is high, by 8-14nm, and taking out and reflecting soft X ray including the band where the reflection factor of a multilayer X-ray reflective mirror is high.

[0020] Like claim 7, a particle and a gas are mixed, it considers as a target, a target fuel injection equipment injects a target, and other descriptions of this invention have recovery opening in which a target recovery system counters and carries out opening to the injection tip of a target fuel injection equipment, and collect targets, and laser radiation

equipment has them in irradiating a laser beam at the target between an injection tip and recovery opening. Since the particle which was not plasma-ized and the particles which returned to the steady state are collected according to this description, the inside of a vacuum housing can be maintained at low voltage, and loss of the generated X-ray can be prevented.

[0021] Other descriptions of this invention are for a condensing mirror to lead to a mask the X-ray generated in the laser plasma X line source of any 1 term of claim 1-7, reduce the X-ray which the X-ray cutback exposure mirror reflected with the mask, and project on a semi-conductor wafer like claim 8. According to this description, by the laser plasma X line source, since there is little generating of debris, breakage on X-ray optical elements, such as a condensing mirror of a semi-conductor aligner, a mask, and an X-ray cutback exposure mirror, or a vacuum septum can be prevented. Moreover, since an X-ray with high brightness is supplied to stability from a laser plasma X line source, exposure does not run short and the exposure time can be shortened.

[0022] The step to which other descriptions of this invention are mixed and use as a target the particle and gas which coated the matter with specific gravity smaller than said metal with the metal, and were made like claim 9, The step which injects said target in a vacuum housing, and the step which a laser beam is irradiated [step] at the target injected in said vacuum housing, and makes the plasma generate, It is the semiconductor device exposure approach characterized by leading the X-ray which was made to generate an X-ray and was generated from the plasma to a semi-conductor wafer, and exposing a semiconductor device pattern to said semi-conductor wafer. If it has this description, since there is little transfer of heat, since there is little generating of debris, breakage on X-ray optical elements, such as a condensing mirror of a semi-conductor aligner, a mask, and an X-ray cutback exposure mirror, or a vacuum septum can be prevented according to a laser plasma X line source with a gas between particles. Moreover, since specific gravity can be made small compared with a metaled particle and the consistency of a particle can be raised, an X-ray with high brightness is supplied to stability from a laser plasma X line source, exposure does not run short, and the exposure time can be shortened.

[0023]

[Embodiment of the Invention] Artificers invented carrying out a solid-state or a liquid with the target of the shape of a particle sufficiently smaller than the diameter of laser paying attention to the high X-ray conversion efficiency of a solid-state and a liquid target and the high brightness of an X-ray, and debris with few gas targets. And in order to be stabilized and to generate an X-ray, the target of the shape of a particle of a solid-state and a liquid was mixed into the gas, and it invented injecting and supplying into a vacuum housing.

[0024] Moreover, the target with which artificers mixed the particle and gas of a solid-state or a liquid It confirms in an experiment that a breakdown threshold is the same as the breakdown threshold of the particle of a solid-state or a liquid about (particle mixing Gaster get is called hereafter) although the gas is included. Massive, and the target (a particle target is called hereafter) which consists only of a particle of a solid-state or a liquid although it is a little smaller than tape-like a solid-state or a liquid target and the target which consists only of a gas (a gas target is called hereafter.) It discovered comparing and having big X-ray conversion efficiency.

[0025] Below, the example of the semi-conductor aligner using X line source and it using particle mixing Gaster get is explained.

[0026] (Example 1) The semi-conductor aligner using the laser plasma X line source which is the 1st example of this invention is shown in drawing 1 . A semi-conductor aligner consists of the X-ray generating sections 100 and the exposure sections 200 which generate an X-ray. The exposure section 200 leads X-ray 14 generated in the X-ray generating section 100 to a mask 16 by the X-ray condensing mirror 15, reduces the mask pattern reflected with the mask 16 by the X-ray cutback exposure mirror 17, and projects it on a wafer 18 (sample). Next, the X-ray generating section 100 is explained in detail. The X-ray generating section 100 consists of the vacuum housing 5 which encloses the surroundings of a target, a target feeder 110 supplied in a vacuum housing 5 by using particle mixed gas as a target, laser radiation equipment 120 which irradiates a laser beam 2 at the particle mixing Gaster get 10, and a target recovery system 130 which collects the particle mixed gas in a vacuum housing 5.

[0027] So that the target feeder 110 may serve as a diameter of 1 micrometer - 3 micrometers sufficiently smaller than 100 micrometers of number 10-micrometerof diameter diameters of laser - numbers The particle which coated the particle tank 6 by which it filled up with the particle which coated the metal, the gas bomb 7 with which it filled up with gas with the high rate of radioparency, and the metal supplied from the particle tank 6, It has the supply nozzle 9 which injects the particle mixed gas built with the mixer 8 which mixes the gas supplied from a gas bomb 7, and the

mixer 8 in a vacuum housing 5.
[0028] Laser radiation equipment 120 is equipped with the laser beam generator 1 which generates a laser beam 2, and the convergent lens 3 which converges a laser beam 2. Pulse width, such as an YAG laser and excimer laser, is several 10 or less ns, and the laser beam generator 1 has that good in which the output per one pulse generates the laser beam 2 of several 10 J from several 10 mJ(s). A laser beam 2 is on the particle mixing Gaster get in a vacuum housing 5, and it converges it with a convergent lens 3 so that it may become several 10 - 100 micrometers of numbers. In order to generate the laser plasma 11, the energy density on the particle mixing Gaster get 10 is 1015 - 1022 W/m2. Extent is good.
[0029] The target recovery system 130 is supplied in a vacuum housing 5, and or it did not plasma-ize, it is equipped with the recovery duct 12 which draws the particle which coated the metal which returned to the steady state, and a reclaimer 13.
[0030] In the vacuum housing 5, it is arranged so that the injection tip of the supply nozzle 9 and recovery opening of the recovery duct 12 may counter. The laser beam 2 from laser radiation equipment 120 penetrates the laser beam transparency aperture 4 prepared in the wall surface of a vacuum housing 5, and is irradiated by the particle mixing Gaster get 10 injected from the supply nozzle 9. The inside of a vacuum housing 5 is maintained at the low voltage force by the vacuum pump (not shown). For example, if the pressure in a vacuum housing 5 is set to 10-2 - 10-3torr and the pressure in the supply nozzle 9 is carried out more than Number torr, it spouts and the particle mixing Gaster get 10 will be in the condition of a fluid. And or it did not plasma-ize, the particle mixing Gaster get 10 which returned to the steady state goes into the recovery duct 12, and is removed from the inside of a vacuum housing 5.
[0031] If the laser beam 2 completed as the particle mixing Gaster get 10 is irradiated, the metallic element coating particle under particle mixing Gaster get 10 will ionize by carrying out dielectric breakdown (optical breakdown) optically by the powerful electric field of a laser beam 2 etc. the range through which the electron generated by ionization of a metallic element coating particle absorbs the energy of a laser beam 2 according to processes, such as reverse braking radiation, and is heated, and the laser beam 2 of the particle mixing Gaster get 10 pierces -- an elevated temperature -- the high-density laser plasma 11 is formed.
[0032] The electron temperature and the consistency of the laser plasma 11 are 1020-1022-/cm3 at several 100eV or more and electron density in electron temperature, although it changes with the class of metallic element which is contained in the particle mixing Gaster get 10 and by which coating was carried out, and the class and conditions of laser. It is good for the plasma of extent to occur.
[0033] Characteristic X ray is emitted by the process of the restraint-restraint transition which the X-ray of a continuous spectrum is emitted by the process of the freedom-free transition which can be set like braking radiation of the electron in the laser plasma 11, and the recombination fault of the plasma, or freedom-restraint transition from the laser plasma 11, and can be set like the recombination fault of the plasma. The X-ray emitted from the laser plasma 11 is used in the adjoining exposure section 200.
[0034] Next, the particle mixing Gaster get 10 injected in a vacuum housing from a supply nozzle is explained.
[0035] The configuration of the particle mixing Gaster get 10 injected in a vacuum housing from the supply nozzle 9 is shown in drawing 2 . Gas 10c, such as 10d of particles and nitrogen, is mixed, and the particle mixing Gaster get 10 is constituted. If the laser beam 2 which it converged is irradiated by 10d of particles, dielectric breakdown will be carried out optically, the laser plasma 11 will be formed, and X-ray 14 will be emitted from this laser plasma 11. It is important to make high density generate 10d of particles which are the main factors which form this X-ray 14 for making it stability what has high brightness, and form the laser plasma 11 in elevated-temperature high density in gas 10c. In the target feeder 110, since the weight of the particle in which per unit time amount is made to generate and it deals is restricted, the particle number which can be generated if specific gravity is heavy is restricted. Like drawing 5 as an ingredient, although an element with the generating reinforcement of 8-14nm soft X ray higher than copper (symbol of element Cu) and nickel (symbol of element nickel) is desirable In the semi-conductor aligner using the multilayer X-ray reflective mirror which has the reflection factor property of drawing 6 especially Since the reflective effectiveness of soft X ray in which wavelength is 13nm is good, in order to use an X-ray for semi-conductor exposure efficiently, the tin which is an element with the high generating reinforcement of the soft X ray whose wavelength is 13nm, gold, and a tungsten are used. Since specific gravity is as large as 7.3, 19, and 19 respectively, the relation between the specific gravity of a particle and the consistency of a particle to densification is [alone] difficult for tin, gold, a tungsten, etc. like drawing 7 . Then, specific gravity can be made small by using the particle of 1-micrometer diameter

which coated organic substance 10a, such as polystyrene, with metal 10b, such as gold, to 3 micrometer. Thus, the specific gravity W at the time of coating a front face with different matter is expressed with a degree type. Here, the specific gravity of the matter which coated w1 and a front face with the specific gravity of organic substance 10a which is the matter used as a nucleus is set to w2, a whole product is set to A, and the volume of the matter which coated a1 and a front face with the volume of the matter used as a nucleus is set to a2.

[0036]

[Equation 1]

W=(w1 and a1+w2, a2)/A -- (formula 1)

The specific gravity W of 10d of particles which coated organic substance 10a, such as A=a1+a2, therefore polystyrene, with metal 10b, such as gold It is the volume of the matter which coated a1=0.9 and a front face with the volume of the matter which sets the specific gravity of w1=1.05 and gold to w2=19, sets a whole product to A= 1, and serves as a nucleus in the specific gravity of polystyrene a2=0.1 If it carries out (several 1), specific gravity W will be 2.85. It becomes. Thus, since specific gravity can be made small, high density can be made to generate a particle.

[0037] This specific gravity w1=1.05 Although polystyrene is used as organic substance 10a by this example Although it is possible to use since it is light compared with a monomer, is strong and it lasts long even if it is the polymer particle of others which were hung up over a table 1 The ingredient near the range of the coefficient of linear expansion of the above-mentioned metal with which there is least average coefficient of linear expansion by heat in a table 1 as 6x10-5 to 8x10-5, and coating is carried out (0.46x10-5 to 2.3x10-5) is chosen. Even if a heating process is added to 10d of particles, the exfoliation and omission of coating by the differential thermal expansion with the above-mentioned metal by which coating is carried out to 10d of selected organic substances are avoided, and it is made to contribute to conversion to an efficient positive X-ray.

[0038]

[A table 1]

表 1

項目	ポリスチレン	ポリ塩化ビニル	ポリエチレン	フッ素樹脂
成形加工性	優	優	優	優
比重	1.05	1.35	0.95	2.1
熱膨張率(10^{-5}/℃)	6～8	5～11	11～13	10

[0039] Furthermore, in order to take out this X-ray 14 in the condition that brightness is high, the permeability of X-ray 14 in gas 10c is important. It is necessary to select gas with the high rate of radioparency as a candidate of gas 10c. The comparison of the rate of radioparency of gas is shown in drawing 3 . The pressure of the derivation conditions of this rate of radioparency is a time of 1torr and distance being 1cm. An axis of abscissa is wavelength, an axis of ordinate is the permeability of an X-ray, helium (symbol of element helium), oxygen (symbol of element O2), and a thick broken line show neon (symbol of element Ne), and a continuous line shows [a dashed line / nitrogen (symbol of element N2), a krypton (symbol of element Kr), and a thin line / air, an argon (symbol of element Ar), and a broken line] a xenon (symbol of element Xe). For the specific wavelength of a required X-ray, when 13nm, this thing with high permeability serves as helium, an argon, nitrogen, air, oxygen, neon, a krypton, and a xenon from high order by 13nm, and the rate of radioparency is 0.8. Since it is helium, an argon, nitrogen, air, oxygen, and neon that it is above, as gas to be used, helium, an argon, nitrogen, air, oxygen, and neon are suitable. Moreover, since nitrogen and an argon are cheap, they can reduce a running cost.

[0040] According to this example, the following effectiveness is acquired.

[0041] In this example, X-ray conversion efficiency is better than a metal particle target and rare Gaster get by using the particle mixing Gaster get 10 which mixed 10d of particles and gas of a laser beam smaller than a path.

[0042] Since heat conduction is small and melting by heat conduction between 10d of contiguity particles does not happen by gas 10c between 10d of particles, the particle mixing Gaster get 10 can lessen debris.

[0043] Since a laser beam 2 is irradiated by the particle mixing Gaster get 10 which injected the particle mixing Gaster get 10 which mixed 10d of particles which coated organic substance 10a with metal 10b, and gas 10c in the vacuum housing 5, was injected and became a fluid and the particle mixing Gaster get 10 is always supplied to a laser pulse, stability can be made to generate an X-ray in this example.

[0044] Moreover, since 10d of particles coats organic substance 10a with metal 10b, specific gravity can become small and they can make high density generate a particle compared with a metal particle simple substance.
[0045] Moreover, when the front face of 10d of particles is a metal, X-ray conversion efficiency can be made higher than a nonmetallic element.
[0046] Moreover, an X-ray can be taken out in the condition that brightness is high, by selecting the high gas especially whose rate of radioparency is 80%.
[0047] In this example, since the particle mixing Gaster get which was not plasma-ized is collected, the inside of a vacuum housing can be maintained at low voltage, and loss of the generated X-ray can be prevented.
[0048] (Example 2) Drawing 4 explains the 2nd example of this invention. This example forms the eliminator 30 which divides 10d of particles into the target recovery system 130 in the 1st example, returns it to the original particle tank 6, and is recycled.
[0049] Therefore, according to this example, in being able to reduce an equipment maintenance and using an expensive metal like gold as a coating material of an organic substance, it is effective in the ability to reduce a running cost.
[0050]
[Effect of the Invention] Since melting of a particle does not happen in case a laser beam is irradiated at the target and an X-ray is obtained, since the gas which mixed the particle and gas which coated the matter with specific gravity smaller than said metal with the metal, considered as the target and was mixed in the target acts as a heat insulation means between particles according to invention of claim 1, generating of debris can be lessened. Moreover, since a target is always supplied to laser, stability can be made to generate an X-ray. Moreover, since specific gravity becomes small and a particle can generate a particle in high density rather than a metal particle simple substance, if a laser beam is irradiated, the laser plasma will surely be generated, and stability can be made to generate an X-ray, without making a laser beam useless. Moreover, when the front face of a particle is a metal, X-ray conversion efficiency can be made higher than a nonmetallic element.
[0051] According to invention of claim 2, in addition to the effectiveness by invention of claim 1, a polymer is light, and it is strong and lasts long, and using the property which is excellent also in fabricating-operation nature, it acts effective in making small the specific gravity of the particle which constitutes a target, fabricating-operation nature is also excellent, and desirable effectiveness is acquired by particle manufacture.
[0052] According to invention of claim 3, in addition to the effectiveness by invention of claim 2, specific gravity is smaller than the polymer of others [polymer / of a polystyrene system], and while coefficient of thermal expansion can also make still smaller the specific gravity of the particle which constitutes a target since it is small, the effectiveness that adverse effects, such as exfoliation by the differential thermal expansion of the coating metal to a particle, are made few is acquired.
[0053] According to invention of claim 4, in addition to the effectiveness by invention of claim 1, many particles exist by the plasma-ized possible field, and the brightness of the X-ray to generate can be made higher according to it being smaller than the path of the laser beam by which the path of a particle is irradiated by the target.
[0054] According to invention of claim 5, in addition to the effectiveness by invention of any 1 term from claim 1 to claim 4, the 8-14nm soft X ray used with a semi-conductor aligner can be obtained efficiently.
[0055] Since according to invention of claim 6 in addition to the effectiveness by invention of claim 5 attenuation according 8-14nm soft X ray to a gas is lessened and is penetrated efficiently, soft X ray can be taken out in the condition that brightness is high.
[0056] According to invention of claim 7, in addition to the effectiveness by invention of any 1 term from claim 1 to claim 6, targets can be collected, the inside of a vacuum housing can be maintained at low voltage, and loss of the generated X-ray can be prevented.
[0057] According to invention of claim 8, by the laser plasma X line source, since there is little generating of debris, breakage on X-ray optical elements, such as a condensing mirror of a semi-conductor aligner, a mask, and an X-ray cutback exposure mirror, or a vacuum septum can be prevented. Moreover, since an X-ray with high brightness is supplied to stability from a laser plasma X line source, exposure does not run short and the exposure time can be shortened.
[0058] According to invention of claim 9, the semiconductor device exposure approach of demonstrating the breakage depressor effect of the semi-conductor aligner by debris and the effectiveness of canceling a underexposure, shortening the exposure time and shortening exposure working hours can be offered.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the whole semi-conductor aligner schematic diagram using the laser plasma X line source by the 1st example of this invention.
[Drawing 2] It is drawing showing the configuration of the particle mixing Gaster get injected in a vacuum housing from the supply nozzle in drawing 1 .
[Drawing 3] It is the graphical representation showing the comparison of the rate of radioparency of gas.
[Drawing 4] It is the whole semi-conductor aligner schematic diagram using the laser plasma X line source by the 2nd example of this invention.
[Drawing 5] It is the graphical representation of the X-ray generating reinforcement of each metal by which coating is carried out to the particle used in each example of this invention.
[Drawing 6] It is the graphical representation showing the reflection factor of the multilayer X-ray reflective mirror of X line each wavelength.
[Drawing 7] It is the graphical representation having shown the relation between the specific gravity of a particle, and the consistency of a particle.
[Description of Notations]
1 [-- Laser beam transparency aperture,] -- A laser beam generator, 2 -- A laser beam, 3 -- A convergent lens, 4 5 [-- A mixer, 9 / -- Supply nozzle,] -- A vacuum housing, 6 -- A particle tank, 7 -- A gas bomb, 8 10 -- Particle mixing Gaster get, 11 -- The laser plasma, 12 -- Recovery duct, 13 [-- Mask,] -- A reclaimer, 14 -- An X-ray, 15 -- An X-ray condensing mirror, 16 17 [-- An evacuation system, 30 / -- An eliminator, 31 / -- Piping for recycle, 100 / -- The X-ray generating section, 110 / -- A target feeder, 120 / -- Laser radiation equipment, 130 / -- A target recovery system, 200 / -- Exposure section.] -- An X-ray cutback exposure mirror, 18 -- A wafer, 19 -- An aligner, 20

[Translation done.]

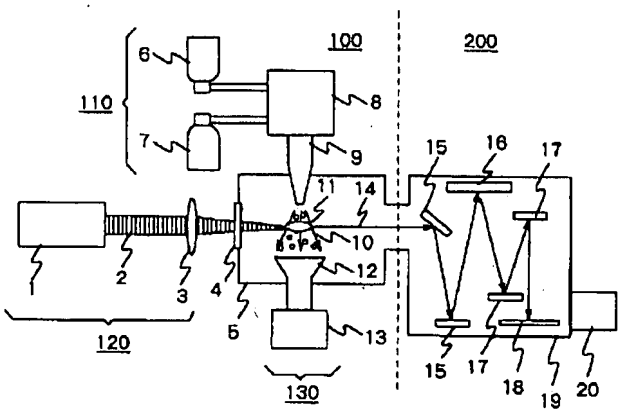
* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

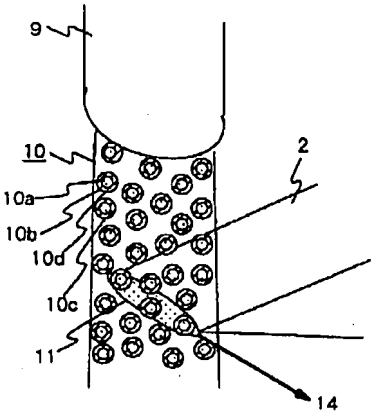
[Drawing 1]

図 1



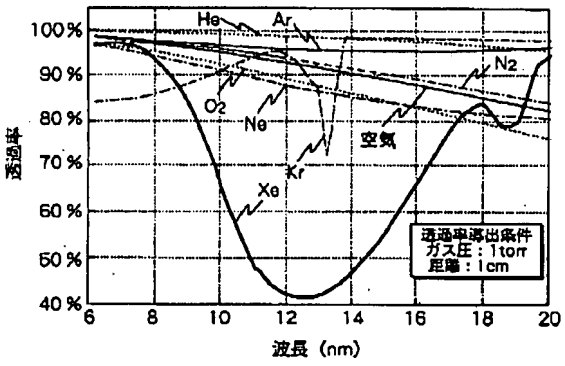
[Drawing 2]

図 2



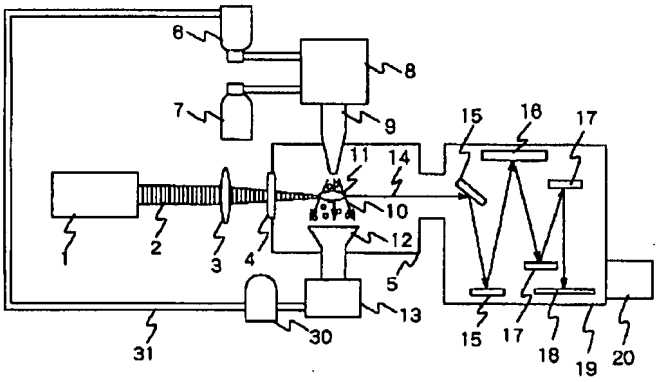
[Drawing 3]

図 3



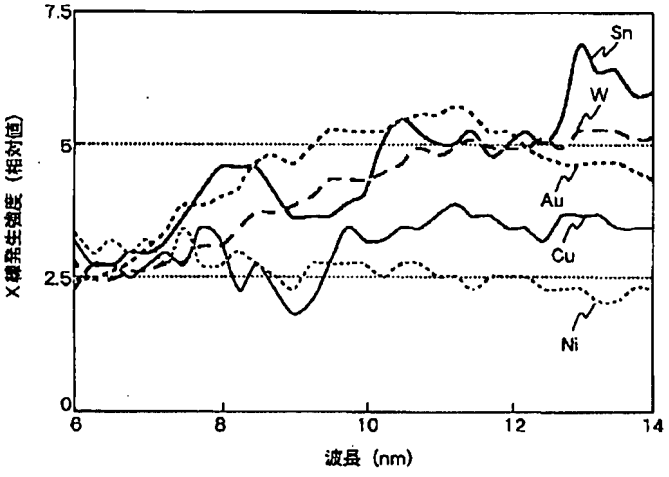
[Drawing 4]

図 4



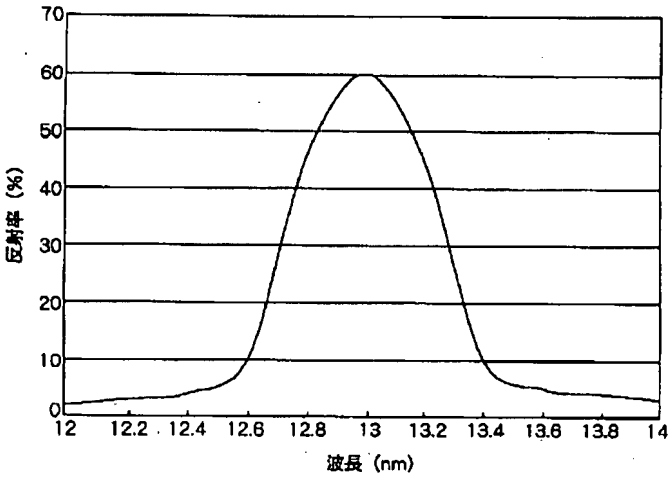
[Drawing 5]

図 5



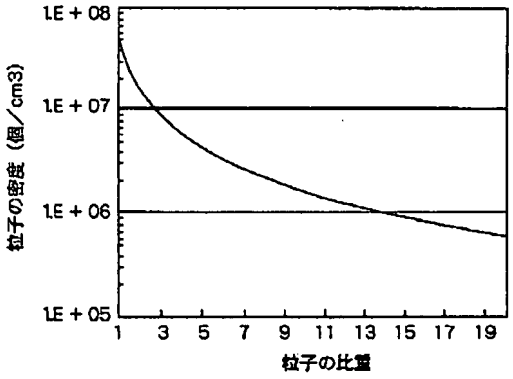
[Drawing 6]

図 6



[Drawing 7]

図 7



[Translation done.]